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베이지안 기법에 근거한 선박사고 발생 확률 계산에 관한 연구

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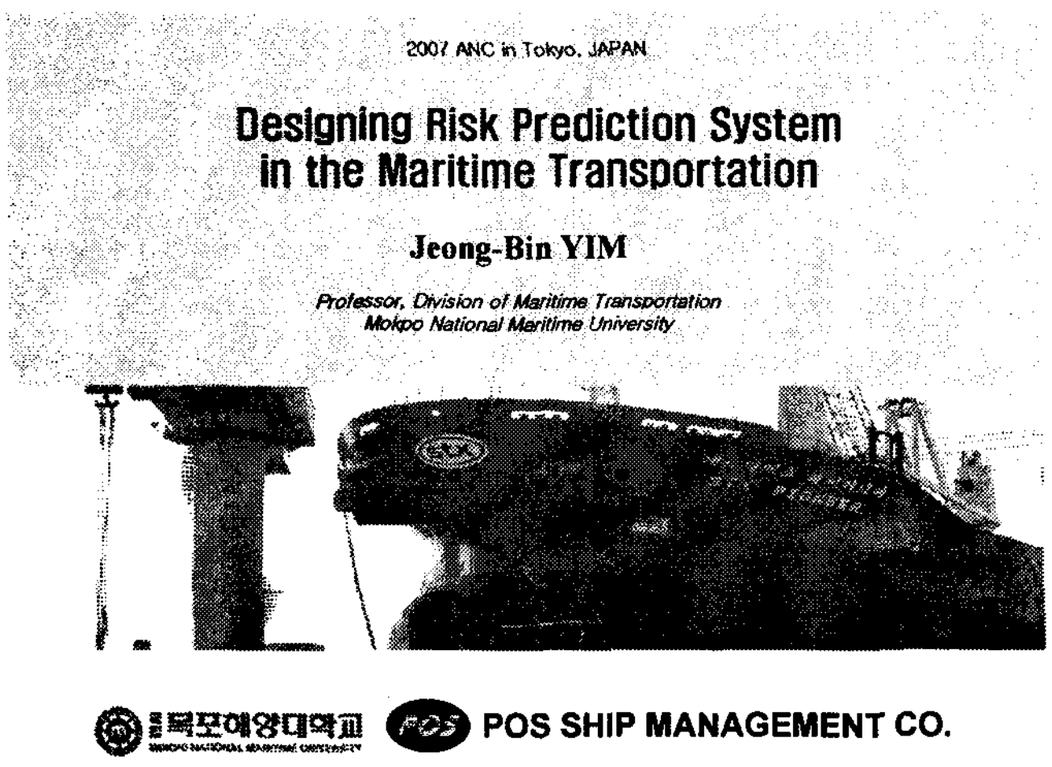
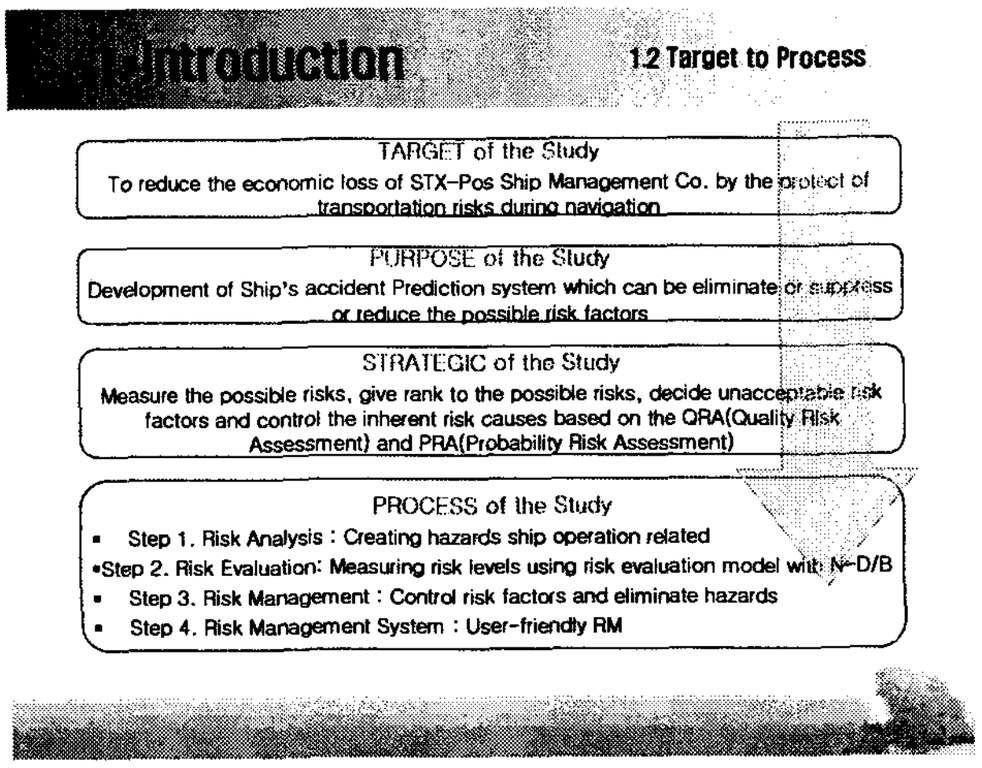
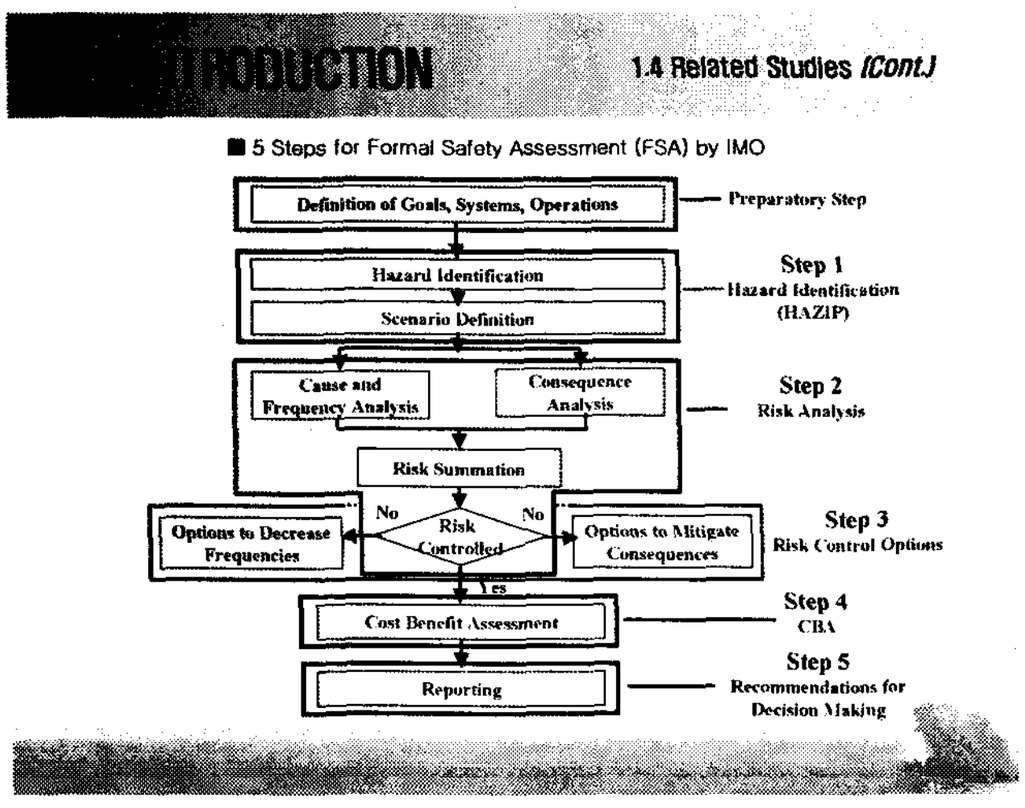
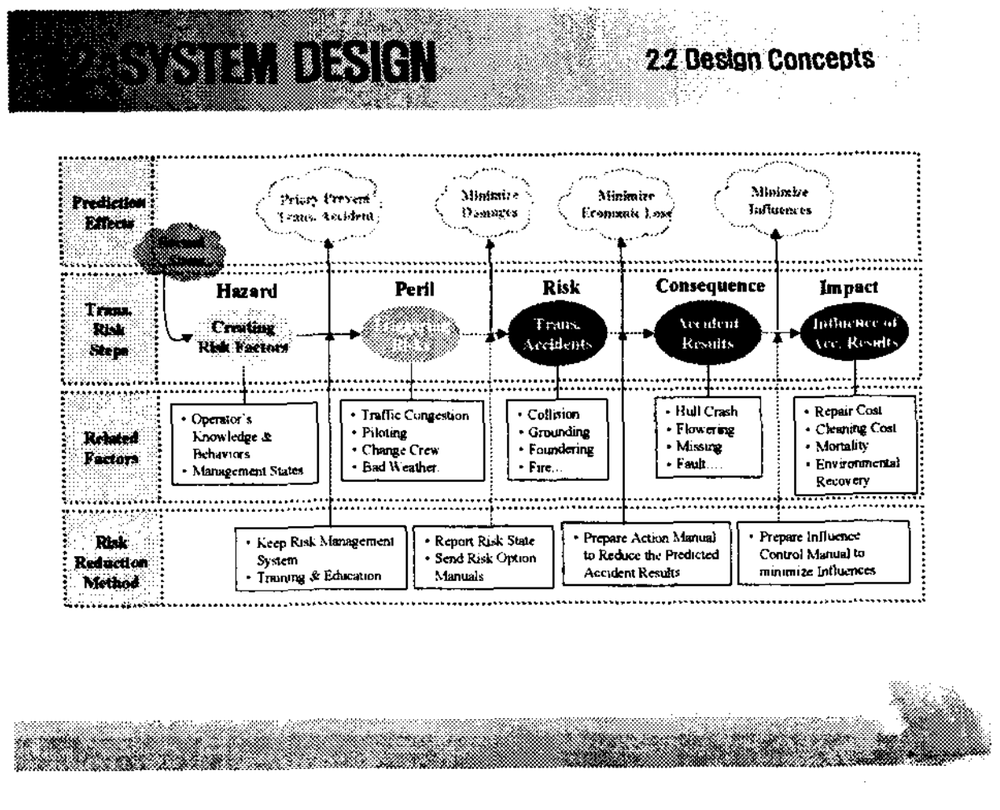
요 약 : 기존 선박사고 자료를 이용하여 향후 발생 가능한 선박사고의 확률을 계산하기 위한 이론과 프로그램 및 실험결과를 나타낸다. 기본적으로 베이지안 기법을 적용하여 다양한 사고의 원인과 결과 사이에 발생하는 인과관계를 통계적 기법으로 다양한 사고들이 발생할 수 있는 사고확률을 계산하였다. 계산을 위하여 프로그램을 개발하고, 이 프로그램을 이용하여 제안한 방법의 유용성을 검증하였다.

핵심용어 : 선박사고, 사고확률, 베이지안, 사고인과관계, 예측 프로그램









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(2) Explanatory Variables & Nominal Scales to express hazards in accidents

■ Available data

- STX-POS Accident History Recording book : 356 Formal Accident Reports, 3,600 Unformed Accident Reports
- STX-POS Fleet List with specifications : 136 ship including 80 current managing ship
- STX-POS Crew Management List and History : Over 2,000 crew members (incl. foreign crews)

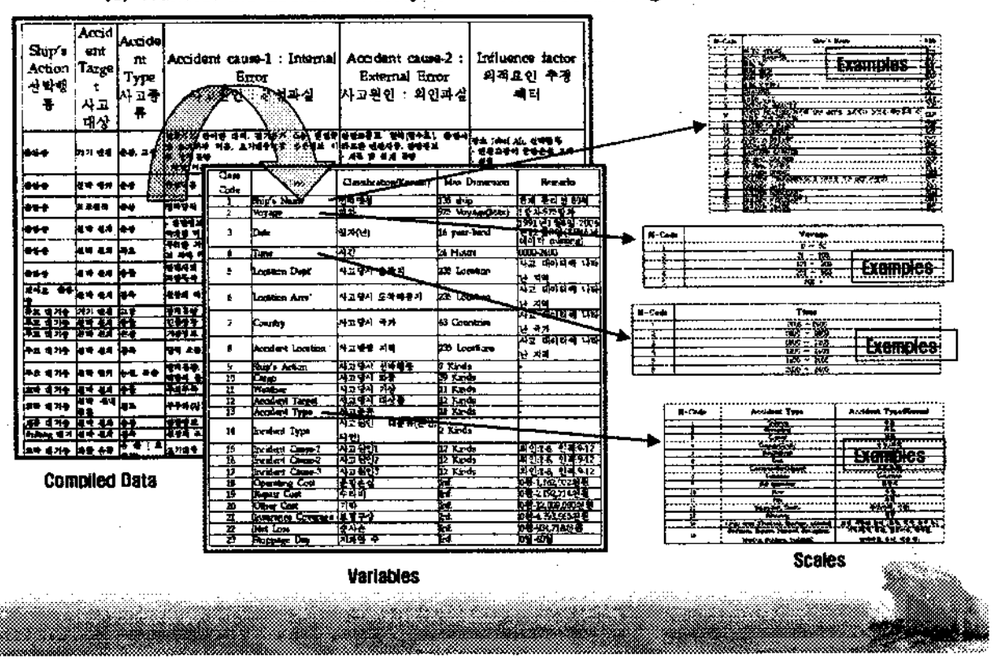
■ Explanatory Variables

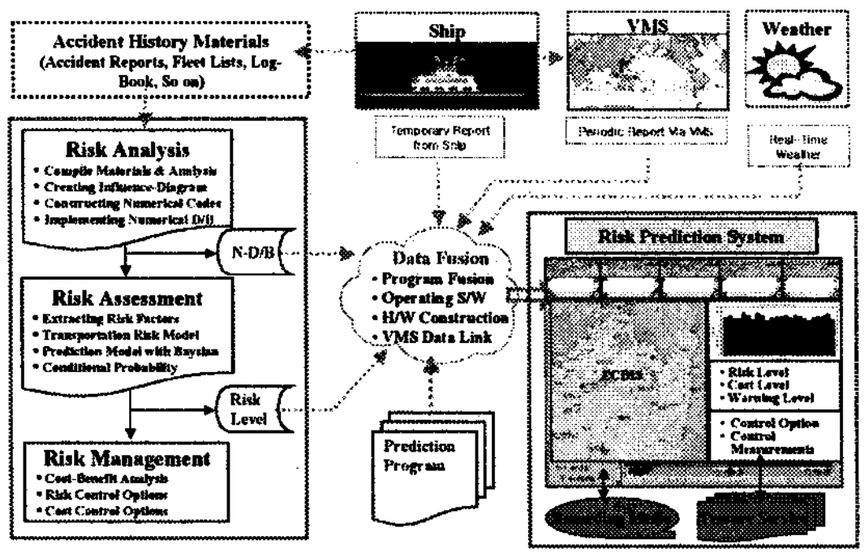
- 23 Accident Relate Expression Variables (Ship's Name, Voyage, Date, Time, Location Dept', Location Arrv', Country, Accident Location, Ship's Action, Cargo, Weather, Accident Target, Accident Type, Incident Type, Incident Cause-1, Incident Cause-2, Incident Cause-3, Operating Cost, Repair Cost, Other Cost, Insurance Coverage, Net Loss, Stoppage Day
- 9 Fleet Related expression variables (Ship ID, Flag, Class, Type, Tonnage, Builder, Builder Country, Building Company, Managing Duration)

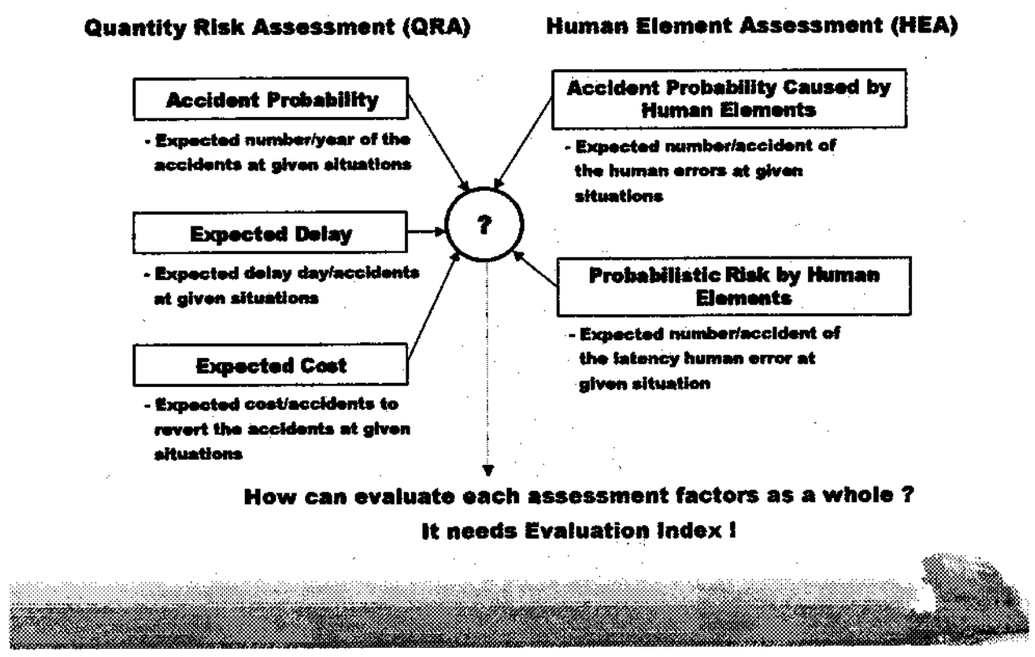
■ Nominal Scales

- Ship's Name 136 x Voyage 1~1000 x Date 197~2006 x Time 0000~2400 x Location 236 x Country 64 Ship's Action 7 x Cargo 39 x Weather 11 x Accident Target 12 x Accident Type 15 x Incident Type 2 x Incident Cause-1 12 x Incident Cause-2 12 x Incident Cause-3 12 x Operating Cost (number), Repair Cost (number), Other Cost (number), Insurance Coverage (number), Net Loss (number) x Stoppage Day (number) x Ship ID 136 x Flag 3 x Class 3 x Type 5 x Tonnage (number) x Builder Country 10 x Building Company 52 x Managing Duration (number)

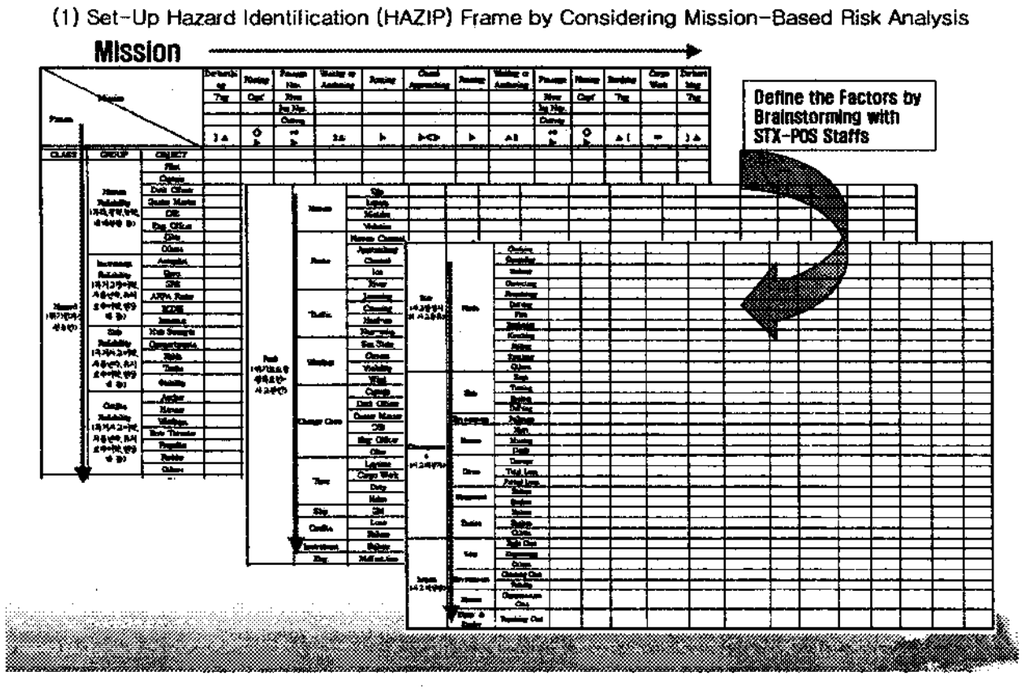
(3) Transfer the accident history to numerical data using Variables & Scales







(1) Set-Up Hazard Identification (HAZIP) Frame by Considering Mission-Based Risk Analysis



■ Probability Index (PI)

- Accident Probability calculate based on the Bayer's Method with Conditional Prob.
- P(Accident I Situation) = P(Accident) x P(Accident I Target) x P(Accident I Target I Cause) x P(Accident I Target I Cause I Situation_1) x P(Accident I Target I Cause I Situation_2) ... x P(Accident I Target I Cause I Situation_23)
  Situation = combination of 23 explanatory variables inc. nominal scales
- P'(Accident I Situation) = P(Accident) x P(Accident I Target) x P(Accident I Target I Cause) x average [P(Accident I Target I Cause I Situation(23)]
- PI Level : 0.001/Year < (PI=1), 0.001/Year-0.01/Year (PI=2), 0.01/Year-0.1/Year (PI=3), 0.1/Year-1.0/Year (PI=4), 1.0/Year-10/Year (PI=5), >10.0/Year (PI=6)

■ Delay Index (DI)

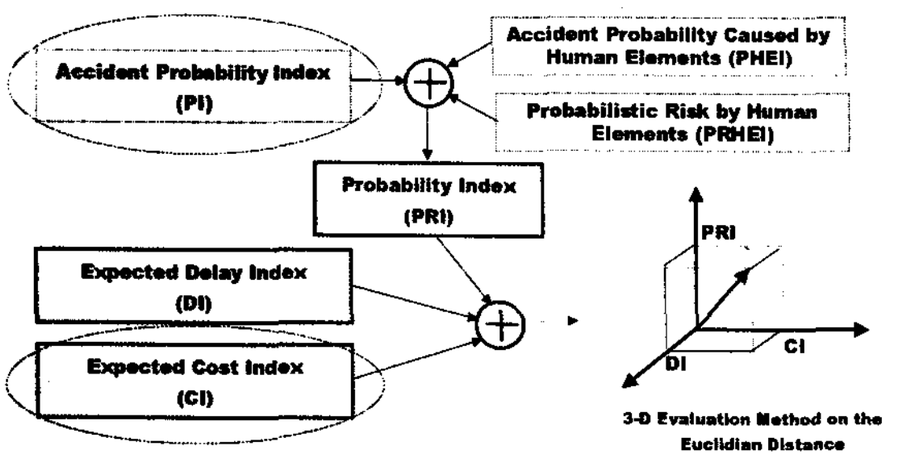
- Based on the repair delay time according to the situations
- DI Level : 0.5 day/accident < (DI=1), 0.5-1.0 day/ accident (DI=2), 1.0-3.0 day/ accident (DI=3), 3.0-5.0 day/ accident (DI=4), 5.0-10.0 day/ accident (DI=5), 10.0 day/ accident > (DI=6)

■ Cost Index (CI)

- Based on the total cost to revert the accidents
- CI Level : 50,000$/event < (CI=1), 50,000$-100,000$/event (CI=2), 100,000$-200,000$/event(CI=3), 200,000$-1,000,000$/event (CI=4), >1,000,000$/event (CI=5)

RISK ASSESSMENT — 4.4 Risk Evaluation

Quantity Risk Assessment (QRA) **Human Element Assessment (HEA)**



3-D Evaluation Method on the Euclidian Distance

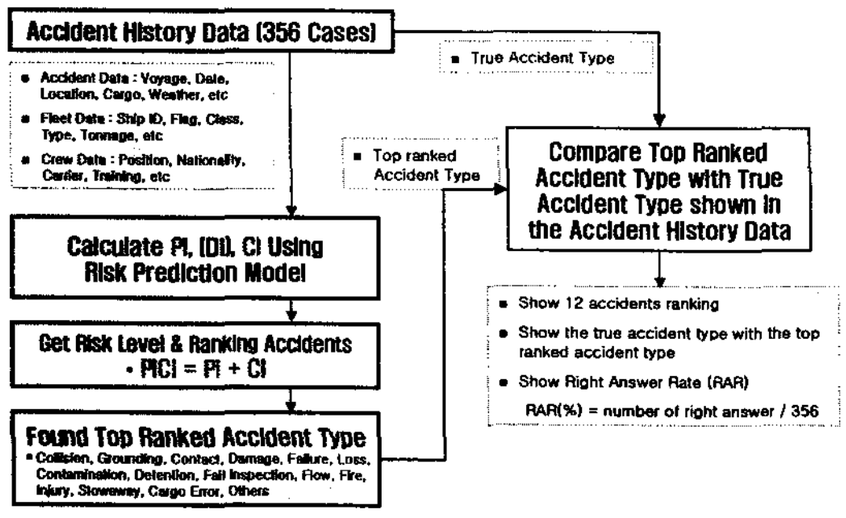
CONCLUSIONS

- Explored Risk Management Techniques and Methodologies including Formal Safety Assessment (FSA) by IMO
- Overviewed the design technique of Maritime Transportation Risk Prediction System & established the system frame and the related design concepts
- Carried out Risk Analysis as followings,
  - Identified hazards to the maritime transportation of STX Pos Co., in KOREA
  - Set the 32 explanatory variables with nominal scales to express whole situation of the accidents
- Carried out Risk Assessment as followings,
  - Set the assessment model with QRA and HEA
  - Obtain the accident Probability Index (PI) based on the Baye's concepts & expected Cost Index (CI) except DI and HEA
- Carried out experiment to verify the proposed system and index value PI, CI
  - Get right answer rate with over 90% (high confidence)

  Now this work going on the Human Element Assessment (HREA) with crew member history data – it may finish the end of 2008

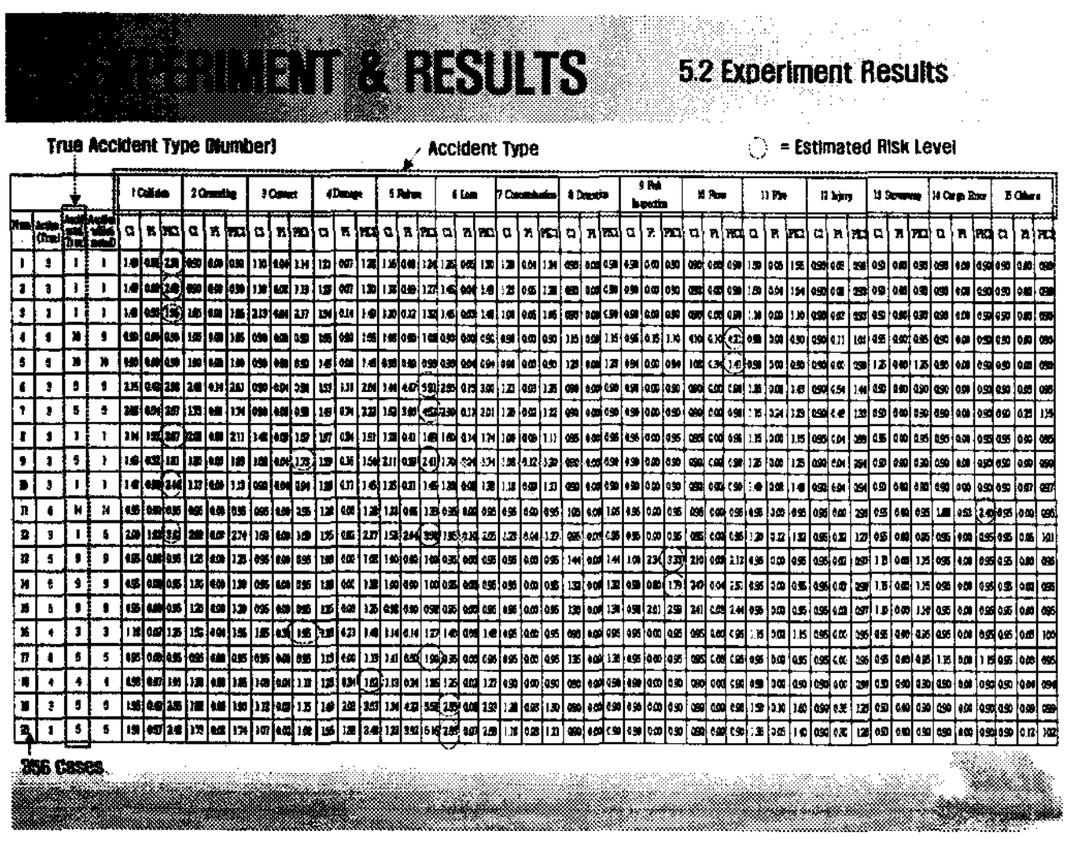
EXPERIMENT & RESULTS — 5.1 Experiment Method

Test to verify proposed method & prediction model briefly



EXPERIMENT & RESULTS — 5.2 Experiment Results

True Accident Type (Number) — Accident Type — ○ = Estimated Risk Level



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